

Investigation of the Desulfurization of Petroleum Distillates using Novel Ionic Liquids

ABSTRACT

The use of fuels (from crude oil) in vehicles is responsible for one of the biggest environmental challenges; SO₂ emission. As a result most countries regulate their sulfur emissions, with the goal of getting to the use of 10 ppm sulfur fuels. These stringent fuel sulfur content requirements have resulted in intensive research being directed at alternative desulfurization technologies which will ensure the treatment of fuels to acceptable sulfur levels. Extractive desulfurization using ionic liquids (IL) may be considered as one of the most promising of these technologies and is the subject of the study presented in this work.

This study served two major purposes: (1) to investigate the capacity as well as key parameters which affect the extraction efficiency of the IL; 1-butyl-3-methylimidazolium octylsulfate as a solvent for deep extractive desulfurization of real Fluid Catalytic Cracking Unit (FCCU) diesel fuel samples collected from a typical South African Refinery, (2) to study/find suitable solvents for the regeneration of sulfur-loaded 1-butyl-3-methylimidazolium octylsulfate and the efficiency and effectiveness of the regenerated IL in the desulfurization of diesel fuel. 1-butyl-3-methylimidazolium octylsulfate was selected due to its properties i.e. good extractive ability for S-compounds and insolubility in fuel oils.

A 22.1% sulfur removal was achieved in the desulfurization of FCCU feed stream diesel fuel, while 96% sulfur removal was achieved for FCCU product stream diesel fuel. These results show that the IL is more effective in the selective removal of sulfur (S) from FCCU diesel product than from FCCU feed stream, suggesting that fuel sulfur content and stream composition affects the extraction efficiency and effectiveness of the IL. Based on thermodynamic considerations, hexane was selected as the most suitable solvent for the re-extraction of sulfur from spent IL. Regenerated IL was used for desulfurization of diesel and achieved highest sulfur removal of 95% and the IL was regenerated up to four times without appreciable decrease in efficiency. The results obtained herein show that ILs are effective in the desulfurization of real diesel oil samples when the sulfur concentration is not very high. Further studies on the recoverability of ILs as well as their environmental impact need to be done to support findings in this study.